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ABSTRACT

Although numeracy demands in today's workplace are rising steadily, the National Adult Literacy Survey (NALS) suggests that many workers do not possess sufficient higher-level numeracy skills. Analysis of the NALS results by occupation reveals that large percentages of workers in a wide variety of industries perform only at the two lower levels of the NALS scale. However, the degree of flexibility and independent working now required of workers corresponds to the three higher levels of the survey. This skills gap needs to be bridged by adult educators who are expert at using workplace context to teach workplace skills. Because many adult educators are now becoming involved in workplace education for the first time, they need guidance in the ways workplace programs differ from more general adult numeracy education. Though workplace programs do often provide traditional General Educational Development and other high school equivalency classes, they also do more by providing several different strands of educational experience. Typical goals of a multistrand workplace program include enhancing job numeracy skills, increasing confidence with numeracy in the home and family, and encouraging further educational experiences. Preparation for teaching these objectives includes the following: analysis of workplace and personal tasks into the skills needed to perform them, custom-designing curriculum around those analyses, and negotiating with funders, management, and workers to produce high-quality programs that will satisfy all parties. (Contains 30 references) (Author/KC)

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ED 431 107

# Numeracy in the Workplace

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## A Comparison of Skill Demands and Skill Levels

**AND**

## Numeracy Skills for Workplace Needs

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# Numeracy in the Workplace:

# A Comparison of Skill Demands and Skill Levels

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**Abstract**

Numeracy demands in today's workplace are rising steadily. Many companies are moving towards a more flexible workforce, often including independent work teams that make their own decisions about productivity and work practices. In such situations, numeracy skills are usually needed in conjunction with information-gathering, problem-solving and communication skills. However, the National Adult Literacy Survey (NALS) suggests that many workers do not possess these skills. Analysis of the NALS results by occupation reveals that large percentages of workers in a wide variety of industries perform only at the two lower levels of the NALS scale. But only the most basic jobs are limited to tasks such as those in these lower levels. Especially in changing workplaces, the degree of flexibility and independent working now required of workers corresponds to the three higher levels of the survey. This skills gap needs to be bridged by adult educators who are expert at using the workplace context to teach workplace skills.

## Purpose

This section sets the scene for the various aspects of workplace numeracy detailed in the following section. It does this by describing the types of demands being placed on employees in today's workplace, and comparing them with the general levels of skills of current workers. From this comparison, a clear need can be seen for workplace numeracy education of a variety of different kinds and at several different levels.

The demands made on the numeracy skills of workers are increasing all the time. More and more organizations now require a flexible workforce capable of performing a variety of different tasks, and often of deciding for themselves what today's tasks will be. As part of teamwork, planning and quality control, workers need to be able to solve problems which often involve the application of numeracy skills. These may well include reading graphical computer output, calculating means and ranges, and making judgments about changing machine settings. (For more detail about the ways in which U.S. workplaces are changing, see Mikulecky, Lloyd, Horwitz, Masker and Siemantel (1996).)

The complexity of modern jobs is well illustrated by the seven skill groups desired by employers, as described by the American Society for Training and Development (Carnevale, Gainer & Meltzer, 1988). These are:

- learning to learn;
- reading, writing, computation;
- oral communication;
- creative thinking, problem solving;
- self-esteem, goal-setting, motivation, personal & career development;
- interpersonal & negotiation skills, teamwork;
- organizational effectiveness, leadership.

Note that the traditional 3 R's form only a small part of this wish list. Much more prominent are issues related to creativity, motivation, communication and teamwork: broad areas which will incorporate a variety of skills and competencies.

More recently, the U.S. Department of Labor (1991, 1992) has established a comparable set of skills guidelines as part of the Secretary's Commission on Achieving Necessary Skills (SCANS). In addition to basic reading, writing and computation, the Commission reports the need for increased competency in the areas of:

- Resources—identifies, organizes, plans and allocates resources;
- Interpersonal—works with others on teams, teaches others, serves clients, exercises leadership, negotiates, and works with diversity;
- Information—acquires, organizes, interprets, evaluates and communicates information;
- Systems—understands complex inter-relationships and can distinguish trends, predict impacts, as well as monitor and correct performance;
- Technology—works with a variety of technologies and can choose appropriate tool for task.

Again, the emphasis is on integration of skills, working in a team and self-motivation. Numeracy demands will form part of this mix, but they will not be required in isolation.

In this section, we consider the nature of these workplace numeracy demands. They can involve calculation, measurement, handling data and problem-solving, often in combination with each other and also with literacy skills. Detailed examples are given of various job tasks and the range of numeracy skills required for carrying them out. We also look at current levels of worker skills, using results from the National Adult Literacy Survey. These raise concerns about the large numbers of workers who do not have the necessary skills to perform adequately in the modern workplace.

## Required workplace skills

Numeracy in the workplace is rarely used in isolation. Often, in order to carry out a task involving numeracy, a worker will also need to read instructions written in prose or consult a document detailing procedures. An example illustrating how this integration of skills occurs has been described by Mikulecky (1989), who worked with the American Bankers Association to determine the nature of basic skills problems in several banking occupations (i.e., teller, customer service representative, loan clerk, secretary, and receptionist). Fifty tasks from these banking occupations were identified as presenting basic skills problems. These tasks called for the use of several basic skills modes (i.e., reading, writing, speaking, listening, and calculating). Over 69% of the identified tasks involved three or more modes and over 22% involved using all five of the above modes. Examples of such multi-mode tasks are:

- dealing with a customer in redeeming a certificate of deposit with interest due, and
- dealing with a customer to check the credit limit on a home equity loan.

Mathematics use was usually called for to solve problems while gathering information from several sources, often requiring the use of technology (i.e., computer or calculator), and with a good deal of speed and accuracy since customers were often waiting for answers to questions.

Now let us consider in detail just what types of numeracy skills are required in the workplace. These types can be divided into four general areas:

- calculation,
- measurement,
- handling data, and
- problem-solving.

This is an artificial separation because several of these skill areas will probably be needed for any workplace task, but it is a useful one for an educator when analyzing the requirements of a particular job or type of job. Using such a division, an educator can break a task down into component skills, find out which of them present workers with most difficulty, and devise curriculum to meet their needs.

Examples of workplace **calculations** include adding up the total price on a delivery form, finding a percentage discount on an insurance premium, subtracting two fractional lengths marked on a blueprint, and working out the proportions for mixing two chemicals. The method used will depend on the calculation and the context in which it is done. A worker will choose (or may be forced into by the circumstances) mental arithmetic, paper-and-pencil or calculator. Ideally, the

worker will check the answer to see if it is reasonable using another, approximate, method. This means that the educator needs to teach the workers how to choose appropriate techniques and how to estimate sensibly, as well as the particular skills needed for the calculations that a job requires.

**Measurement** in the workplace can involve not only direct measuring with ruler or micrometer, but also setting dials on machines which then do the measuring. In either case, care and accuracy are required, as well as an appreciation of the permitted tolerances in a particular situation. Examples include measuring lengths of wood with a ruler to an accuracy of sixteenths of an inch, measuring diameters of wire with a micrometer to within thousandths of an inch, and setting a machine to weigh bags of sugar to an accuracy of tenths of an ounce. In all these cases, workers need to know how much error is allowable and how much will produce problems.

Workplace **data** come in many forms, and so do the methods for handling the data. Much of it is now computerized, and so workers need to be able to interpret what they see on a screen and use a keyboard to react to it. Other workplace data appears as printed graphs, charts or blueprints. For example, a customer service representative dealing with a client's query will have to key in an identity code to bring up on a screen the details of that client's case, and then read off the information relevant to the particular question, and possibly make calculations and changes to the computer entry as a result of that query—and do all this while talking to the client on the telephone. In another case, in manufacturing, a worker monitoring the production of a machine will receive a graphic print-out every hour and will need to interpret the information contained in the graph, in order to make changes to the machine's operation.

**Problem-solving** in the workplace will usually bring together some of the other areas mentioned above, but it has its own characteristics. Principally, problem-solving will entail making judgments: about the information which is needed to make a decision, about the relative weight to give different pieces of information, about the appropriate action to take. Often problem-solving will be a shared activity, requiring communication, teamwork, and analysis of information in various formats. This may make the decision-making less of a burden on one individual, but it involves other skills of cooperation such as explaining clearly, listening carefully and reaching consensus. Because problem-solving interacts so much with the other skill areas, it is difficult to give examples of it in isolation, so it will be considered further in the detailed examples of workplace tasks which follow.

### Examples of workplace numeracy use

We shall now look in detail at how the various types of numeracy skills described above are used in three typical workplace situations. In all three, workers find themselves under pressure to solve a problem, so that either a production process can continue or a customer can be satisfied—and sometimes both of these. In all three, the workers are in control of their own actions—not closely directed by a supervisor, and have to monitor their own progress toward solving the problem. So, in all cases, they will need to draw widely on the range of skills listed by the American Society for Training and Development and by the SCANS, which were mentioned earlier. Note also how *all* the numeracy skill areas can be involved in one workplace task, and that literacy skills are often inextricably woven into the task also.

#### *Example 1 Statistical Process Control*

Statistical Process Control provides a way of monitoring the production of a machine while it is in operation, and making necessary adjustments in order to maintain a standard quality of production. At regular intervals, the machine operator takes samples of the product (which may be bottles of soda, lengths of planking or packages of macaroni and cheese) and **measures** the volume, length or weight of

each unit in the sample. These **data** are then recorded on a form (see Figure 1 at the end of this section) and the mean and the range of the sample values are **calculated**. The worker plots the mean and range on a **graph**, which already includes values from samples taken earlier in the day.

Then comes the **problem-solving**. The worker needs to decide whether production is still within pre-set tolerances and, if not, by how much to adjust the settings on the machine. Too small an adjustment will not solve the problem, whereas too great a change will turn under-weight into over-weight, producing a new problem. Keep in mind that the machine is still in production while all this is happening, and a worker's speed in dealing with the sample and taking the decision will avoid costly wastage of materials and production time. In many businesses, machine output is worth several thousand dollars per hour, so that rapid, accurate, data-driven decisions are crucial.

Clearly, for workers to be able to keep their machines producing units of usable quality, it is necessary for them to have a thorough grasp of what they are doing. And they must certainly avoid mistakes in measuring, recording, calculating and graphing, because any such errors will invalidate the whole process. So the challenge for an educator is to develop in these workers the necessary skills and understanding to carry out Statistical Process Control with accuracy and good judgment.

### *Example 2 Customer Service*

A customer service representative (CSR) handling billing inquiries receives a telephone request for late payment. After asking for the customer's name, the CSR can pull up the whole of that customer's **record** on a computer screen and check on the payment history. At this point, there is an initial **decision** to be made: How reliable is this customer? Can any extension of time be given?

If an extension seems to be in order, the CSR then consults a **set of rules** concerning the length of such an extension and whether some percentage of the bill must be paid immediately. After **calculating** the effect of the rules in this case, the CSR tells the customer the result—and probably generates a discussion on the possibility of the customer paying as required. Again, the CSR must make a **decision**, within the limits of certain discretionary powers, which will produce the solution most likely to lead to payment and a satisfied customer.

Once again, in this example, the worker is processing data, making calculations and taking decisions, all under the pressure of time. Here, it is the customer on the telephone generating the pressure, rather than a machine which continues to produce, but the consequences are the same for an educator: to develop in these workers a thorough understanding of the skills and competencies associated with their jobs.

### *Example 3 Quality Assurance Teams*

In high-performance workplaces, teams of workers representing activities at various stages of production often meet in what are called "quality assurance teams". The purposes of such teams are to identify problems, jointly set new productivity goals, and discuss the results of monitoring productivity at various

stages of production (e.g., where are the mistakes or slow-downs happening and what can be done about it).

A typical team problem is too much inventory on the floor—skids loaded with parts or finished product. A major productivity goal is "just in time" production, so that material is ready for the next stage of production or for the customer exactly when it is needed. This cuts down on spoilage, breakage, pilfering, and needed warehouse space.

To solve problems like this, 4 - 6 workers may spread inventory **graphs** on a table. Such line graphs record the amount of inventory in various locations at various points in time (by the hour, day, week or month). **Synthesizing information** from these graphs can allow the team to determine when there are build-ups of excess inventory (i.e., parts or finished product). Team members will offer **problem-solving** suggestions on why the build-ups are occurring (e.g., the new man at Stage 4 is having a hard time keeping up, the second machine at Stage 3 has been requisitioned for a special order project, breakdowns are occurring on the first machine at Stage 3). Additional information is then gathered on suggested possibilities. For example, what would happen if a worker at Stage 3 went to help at Stage 4 every other hour? Alternative **computations** of output might involve working with half-day or two-hour splits of time. Speculations about machine breakdowns might involve checking when the machine was last overhauled and recalibrated, looking up projected times between maintenance, and computing the time before the next scheduled maintenance. Pulling up machine **records** of the questionable machine during a comparable time during the last maintenance cycle would provide information to justify a call for early maintenance. New and old work orders would be scanned to see how many parts are called for in the special order which took a machine off line. Based on performance so far, **computations** and **estimates** would be made for how long it would remain off line.

The culmination of all this brainstorming and quantitative information-gathering would be a provisional plan to increase production speed and reduce the amount of inventory on the floor. This would involve **deciding** which workers and machines would do what tasks during which times. It would involve setting goals, **counting** and making **measurements** at regular intervals, and **recording data** to monitor the various stages of production. In 3 - 5 days time, the quality assurance team would meet again briefly to determine how well goals had been met and how well problems had been solved.

## Actual worker skills

From the examples above, it can be seen that workers using numeracy in their jobs (especially those in changing workplaces) need to have a thorough grasp of methods in various areas of mathematics. They also need to be able to apply what they know in real-life situations where the appropriate method is often not obvious and where the use of calculators, computers, and graphic representations is called for. In addition, numeracy is not isolated from other types of skills. For instance, the customer service representative of *Example 2* (above) will need to read and interpret descriptions in words on the computer screen, and the manual of rules about extensions will mix prose and numerical information. But these are the very skills that many young people leaving school are likely to lack, because they have learned mathematics in a vacuum without seeing it as connected to real problems. Also, for older workers whose jobs are changing to a more flexible pattern, these are the very skills they will never have had or which they have long forgotten.

To give some idea of the gap between the need for skills in the workplace and the actual skills of workers, consider some of the results of the National Adult Literacy Survey (NALS) (National Center for Educational Statistics, 1993). The more than 26,000 adults who participated in the survey were given tasks of varying difficulty to accomplish using realistic scenarios and materials. The percentage of adults correctly completing various prose, document, and quantitative tasks was used to establish task difficulty ratings along a 0 - 500 scale. Then, each adult surveyed was given a proficiency score on the same scale according to the tasks successfully completed. For example, the task "Total a simple bank deposit entry" was rated at 191 on the quantitative scale, and adults with a proficiency score of 191 would be given that score because they had a high probability (80%) of completing that item. These adults would then have a steadily decreasing probability of success with more difficult tasks given higher ratings of 250, 300, 350, etc.

The full scale 0 - 500 is divided into five levels of task difficulty and respondent proficiency. To give some idea of the five levels, here are some example tasks from each level. These tasks illustrate not only the quantitative scale, which is directly related to numeracy, but also the prose and document scales. This is in order to emphasize the point that the use of such skills in the workplace will usually be integrated across the three areas. (Also, there is some debate about how separate the three scales really are. For example, there are high correlations between achievement results on the prose, document and quantitative scales (Reder, 1995).)

**Selected Tasks from the National Adult Literacy Survey**

| | |
|---|---|
| Level 1<br>(0 - 225) | Identify a country in a short article.<br>Locate the time of meeting on a form.<br>Total a simple bank deposit entry. |
| Level 2<br>(226 - 275) | Locate an intersection on a street map.<br>Calculate postage and fees for certified mail.<br>Calculate the total costs of a purchase from an order form. |
| Level 3<br>(276 - 325) | Write a brief letter explaining a billing error.<br>Find information from a bar graph of energy sources.<br>Calculate miles per gallon using information on a mileage record chart. |
| Level 4<br>(326 - 375) | Explain the difference between two types of employee benefits.<br>Use a table to determine the pattern in oil exports across years.<br>Determine correct change using information on a menu. |
| Level 5<br>(376 - 500) | Summarize two ways lawyers may challenge prospective jurors.<br>Use information in a table to complete a graph, including labeling axes.<br>Using a calculator, determine the total cost of carpet to cover a room. |

The NALS results showed that 21% - 23% of adults nationally perform within Level 1, and 25% - 28% within Level 2. This, of course, includes those not in the workforce, but does indicate that about half the adult population performs at these lower two levels. (More detailed information on those in the workplace is given below.) A comparison of the tasks listed above with the skills now required in many workplaces, particularly those described in the three detailed examples of the last section, shows that many workers have a large skills problem and will find it difficult to carry out jobs which are becoming steadily more complex. This is true of both numeracy skills and others in the prose and document areas, which are needed *together* in order for workers to perform their jobs satisfactorily. As mentioned earlier, the seven skill groups of the American Society for Training and Development (Carnevale, Gainer & Meltzer, 1988) and the guidelines of the Secretary's Commission on Achieving Necessary Skills (U.S. Department of Labor, 1991 & 1992) lay emphasis on higher level competencies that integrate numeracy and other skills in tasks similar to those at Levels 3, 4 and 5.

In fact, only the most basic jobs are limited to the simple use of addition and subtraction represented by Level 1 tasks. Some degree of form filling is called for in 70% of jobs and this often involves taking information from one source (e.g., a table, chart, or machine display) and performing some kind of calculation upon the information. Such relatively simple tasks parallel those of Level 2 on the NALS quantitative scale. Much more typical of changing workplaces, however, are the tasks represented at Levels 3, 4 and 5 which call for problem-solving, setting up computations, gathering information from several sources, and estimating to check the reasonableness of answers. Researchers have consistently found the vast majority of workplace materials—manuals, memos, new product information, trouble-shooting directions—to be of high school or college level difficulty. (See, for example, Mikulecky and Diehl (1980), Sticht (1982), Mikulecky (1982), and Rush, Moe and Storlie (1986).) This is comparable to Level 3 of the NALS.

In most occupations, therefore, workers whose quantitative competencies are only at Level 1 or 2 are obvious candidates for basic skills training. The more detailed NALS results (Mikulecky, 1995) show that average workers' quantitative scores are at Level 2 in the following broad occupation categories. These range, in order, from averages at the top of Level 2 down to about the middle of Level 2:

> Craft, Transportation Operative, Service, Farming/Forestry/Fishing, Laborer, and Machine Operative.

Thus the average worker in each of these categories performs below the level likely to be needed by job requirements in workplaces making changes to become more productive. Such changes involve workers doing more individual quality monitoring, being able to move freely among several job tasks, and interpreting information to answer questions and solve problems.

The categories above, in which average workers score at Level 2, are general occupation areas containing dozens to hundreds of job titles. Among the more specific job areas within these low scoring categories are:

> Food preparation, Cleaning and maintenance, Child care, non-supervisory Farming, Construction and Motor vehicle operators.

These averages give a rough indication of job areas in which most workers may have difficulty with even the relatively simple Level 3 demands of using a calculator to compute price differences or to calculate miles per gallon. Even more revealing, however, are the *percentages* of workers in these jobs whose skills place them at the still lower Levels 1 and 2 (see table below).

## Percentages of Low-Level Numerates in Selected Occupations

| Occupation | Level 1 | Level 2 | Level 1 + 2 |
|---|---|---|---|
| Food preparation | 24% | 33% | 57% |
| Cleaning and maintenance | 45% | 30% | 75% |
| Child care | 18% | 37% | 53% |
| Non-supervisory farming | 32% | 26% | 58% |
| Non-supervisory construction | 21% | 27% | 48% |
| Non-supervisory motor vehicle operators | 21% | 30% | 51% |

It can be seen that, in these example jobs, from half to three-quarters of workers perform below Level 3. And this is the current or near-future requirement for numeracy in their work, as workplaces are down-sized and remaining workers are expected to function independently with new technologies, to monitor quality, and to communicate quantitatively. Food preparation workers are increasingly expected to adjust recipes, monitor sales, take a shift at the cash register, and place orders based on projected needs. Cleaning and maintenance workers mix chemicals by ratios, monitor use and place orders. Child care workers sometimes need to prepare meals satisfying particular nutritional balances, which can involve using charts and graphs, and computing calorific values. Those workers at Level 2 will probably experience difficulty with such tasks. Those at Level 1, regardless of the nature of their workplace, will be unable to do many of the numeracy tasks required of them. It is likely that, when such tasks arise, Level 1 workers must find help, make guesses or simply stop working.

The proficiency levels of workers in these specific job areas appear to be typical of performance in the larger occupational categories. For example, about 30% of both Laborers and Machine Operatives score at Level 1, while another 30 - 35% score at Level 2. Thus three out of every ten workers in these categories are likely to need training in basic numeracy skills, and these lowest level workers will probably require several hundred hours of training and practice at these basic skills before they can benefit from more demanding technical training courses. An additional three out of ten Laborers and Machine Operatives will need to brush up their basic skills before being able to benefit much from technical training activities.

Critics of the kinds of tasks used in the NALS and earlier surveys (see, for example, Harris (1991), pp. 62 - 63, 173 - 175, 206) point out that, even though NALS tasks use realistic materials, they are still paper and pencil tasks which may seem unreal to some adults who might perform adequately in more realistic situations. In addition, the NALS tasks had to be performed independently, so they only show what an adult can do on his or her own. Sometimes adults have others they can call upon for help. However, as down-sizing forces most workers to function independently more of the time, it is important to know what adults can do without help. As to the criticism that the NALS may underestimate what adults can do in more realistic settings: even if the percentages of workers who fail with Level 2 and 3 tasks is as much as one third lower than those found by the NALS, a shockingly high number of workers need additional numeracy training.

However, another result from the NALS data sounds a note of caution: there are regional variations across the country in the scores obtained, which suggests the likelihood of more substantial local variations. It is therefore important for an educator to find out the range of capabilities of those in the actual workplace where training is to take place. National results can only indicate the possible scope of a problem, so an educator needs to develop some form of screening test to find out what the workers in that workp'ace can and cannot do. Only the results of such a test (possibly on a sample of workers for a large organization) will tell an educator the size and nature of the problem she has to deal with.

## Implications and Conclusion

The NALS results listed above paint a depressing picture, but they do point to a way out. The activities in the NALS were all things that people do moderately often, but not as often as a worker on the job will do the tasks associated with that job. A worker monitoring a machine as part of a Statistical Process Control scheme, or a customer service representative taking telephone calls about billing problems, will follow procedures that are at least similar to one another, many times a day. And here lies the opportunity for an educator to raise the achievements of workers beyond the level at which they normally operate. Using curriculum custom-designed around job tasks, an educator can improve workers' skills at such tasks, because of the mutual support between instruction and job practice. The following section provides detailed information on various ways that this can be achieved.

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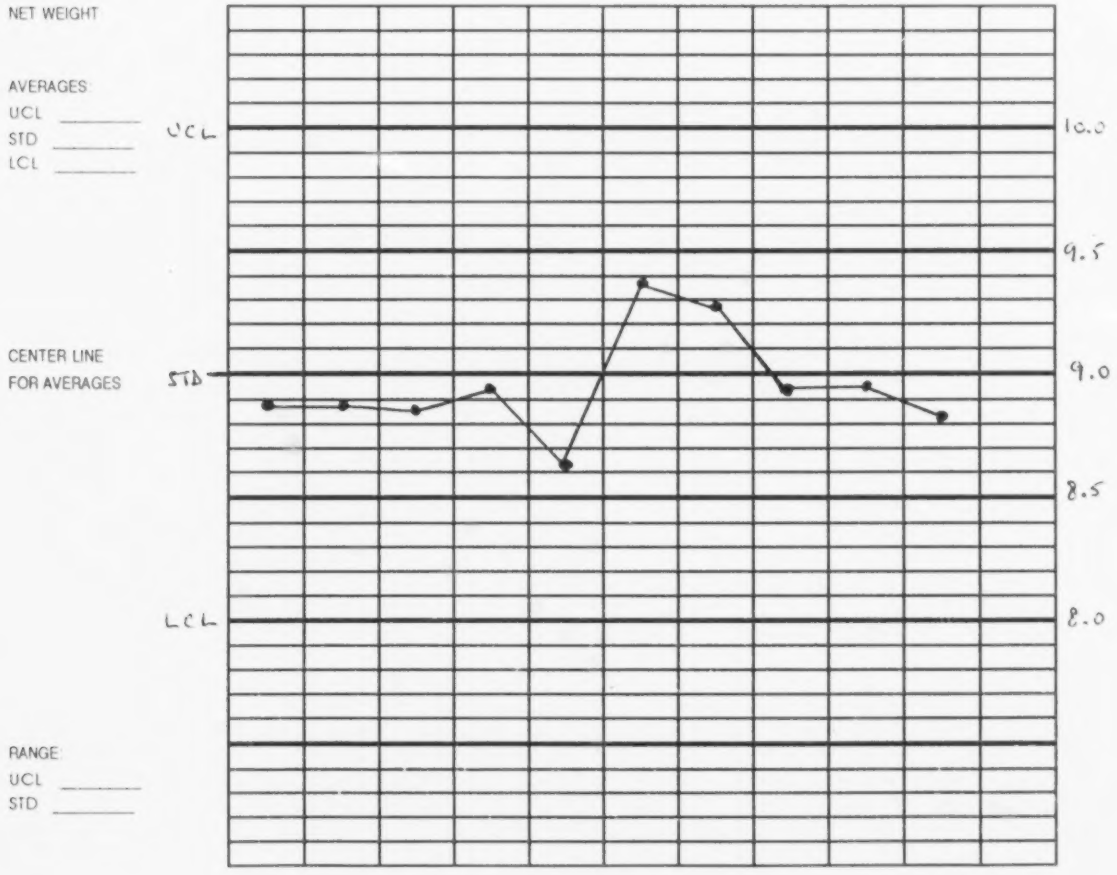
Figure 1

Reed Wright
OPERATOR SIGNATURE

MACARONI + CHEESE
PRODUCT

NET WEIGHT

| TIME | 7:30 | 8:00 | 8:30 | 9:00 | 9:30 | 10:00 | 10:30 | 11:00 | 11:30 | 12:00 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 9.1 | 9.0 | 9.3 | 8.6 | 8.4 | 9.5 | 9.2 | 8.5 | 8.4 | 8.9 | |
| 2 | 8.6 | 8.6 | 8.6 | 8.7 | 8.6 | 9.3 | 9.0 | 9.5 | 9.2 | 9.4 | |
| 3 | 9.0 | 8.9 | 8.9 | 8.9 | 8.5 | 9.5 | 9.3 | 8.4 | 9.5 | 8.7 | |
| 4 | 8.9 | 9.2 | 9.1 | 9.2 | 8.4 | 9.2 | 9.4 | 9.3 | 8.9 | 8.6 | |
| 5 | 8.8 | 8.7 | 8.4 | 9.3 | 9.2 | 9.4 | 9.5 | 9.0 | 8.8 | 8.5 | |
| TOTAL | 44.4 | 44.4 | 44.3 | 44.7 | 43.1 | 46.9 | 46.4 | 44.7 | 44.8 | 44.1 | |
| AVERAGE $\bar{X}$ | 8.88 | 8.88 | 8.86 | 8.94 | 8.62 | 9.38 | 9.28 | 8.94 | 8.96 | 8.82 | |
| RANGE R | .5 | .6 | .9 | .7 | .8 | .3 | .5 | 1.0 | 1.1 | .9 | |

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## Abstract

Many adult educators, both new and experienced, are now becoming involved in workplace education for the first time. They need guidance in the ways workplace programs differ from more general adult numeracy education. Though workplace programs do often provide traditional GED and other high school equivalency classes, they also do more by providing several different strands of educational experience. Typical goals of a multi-strand workplace program include enhancing job numeracy skills, increasing confidence with numeracy in the home and family, and encouraging further educational experiences. Preparation for teaching these objectives includes the analysis of workplace and personal tasks into the skills needed to perform them, custom-designing curriculum around those analyses, and negotiating with funders, management and workers to produce high-quality programs that will satisfy all parties. The same attention to custom-designing and local program demands is called for in evaluating the effectiveness of workplace numeracy programs.

## Purpose

This section considers the issues that an educator needs to address when setting up and implementing a workplace numeracy program. Of course, the general framework described here applies also to the implementation of any other workplace education program. (See, for example, Mikulecky, Lloyd, Kirkley, and Oelker (1996).) Among the questions considered are:

- How do I gain the active support of key players: management and unions, supervisors and workers?
- How can I set up a program that will encourage workers to become life-long learners?
- How do I find out what skills are required in this workplace, and what is causing workers difficulty in their jobs?
- How do I design and select curriculum that is relevant to workers and their jobs?
- How do I evaluate the program in ways that are appropriate to the curriculum and likely to be convincing to funders?

In order to answer such questions, this section sets the scene by describing what makes for a successful program, and then leads the reader through the whole process of organizing a workplace numeracy program, from initial planning and identifying needs, to designing curriculum, through to final evaluation.

**Establishing a Workplace Numeracy Program**

| | |
|---|---|
| 1. Planning and Negotiation | Consult all groups affected by the program, so as to create active involvement |
| 2. Identifying Needs | Gather examples of workplace materials and practices, discovering skills problems |
| 3. Designing Curriculum | Custom-design to address worker needs, using workplace materials and appropriate off-the-shelf materials |
| 4. Evaluating Results | Assess what is taught with job-related measures |

For educators coming to a workplace from an Adult Basic Education background, there are several differences in emphasis and approach that need to be noted. First and foremost, the bottom line in business and industry is just that: the bottom line. The success of a workplace program will be judged to a large extent by its effect on the organization's productivity, profitability, and corporate goals. Also, there are a number of differences in the nature of instruction. Compared with ABE, workplace courses are more likely to involve teaching one curriculum to a whole class, and this curriculum will probably be closely related to specific job tasks and skills. However, this statement, and the contrasts set out below, are generalizations, and should be seen only as

guidelines to the differences between ABE and workplace programs. Indeed, a few workplace programs are simply general ABE programs delivered at a worksite.

### Comparison of ABE and Workplace Education

| ABE | Workplace |
|---|---|
| Established program, often centrally funded | Funding less certain, often depends on results |
| Attendance usually learner's choice | Attendance often required by employer |
| Learners come to program as individuals, usually not knowing each other before | Learners already know each other and come to program with an existing social structure |
| Instruction usually individualized, based on learner goals | Instruction often in groups, covering same curriculum for all learners |
| Instruction on general, academic topics | Instruction often on specific, job-related topics |
| Learners rely on teacher expertise, both in content and pedagogy | Learners are content experts on their jobs, and teachers need to learn as well as teach |
| Assessment of learners, more than of program | Evaluation of program determines refunding |

## Planning and Negotiation

Applications of numeracy in the workplace often differ considerably from approaches found in schools and in general educational materials. Unlike the hundreds of hours available for numeracy education in schools, workplace education is often brief (e.g., a few hours a week for 10 - 12 weeks). For these reasons, workplace numeracy programs are most effective when instruction is targeted and custom-designed to fit tasks and materials called for in specific workplaces.

The basis of an effective workplace numeracy program, therefore, is custom-designing. This occurs at two levels: deciding what workplace-related skills need to be taught, and how they can be taught most effectively. Instructional topics can range from the rudiments of decimal measurement to the basics of means, graphing, and decimals needed for Statistical Process Control. Formats can range from courses to computer lessons to take-home study modules. Audiences to be included in custom-designing include all parties affected by instructional decisions—from management and union as organizations, to workers and supervisors as individuals. The success, or even the existence, of a program may be put at risk if any of the parties is not fully consulted. On the other hand, if all these groups can be persuaded to buy-in to the goals of a numeracy program, it is much more likely to run smoothly and reach those goals.

**Consult All Affected Groups**

- management
- workers
- unions
- supervisors

An educator's initial contact with a workplace will often occur because the management has become aware of a problem which is costing the organization money or endangering restructuring goals—they are feeling "pain" in some way. This "pain" may be related to quality of production, wastage of materials, turnover, absenteeism, or health and safety. Sometimes it is because of workers' inability to benefit from technical training courses built into development plans. These could include courses in blueprint reading, or electrical monitoring and trouble-shooting, or training connected with expanded job descriptions. It is unlikely that the management will know in detail what is causing the problem.

For example, a wood products factory may have an unacceptable level of waste occurring because of measurement errors when workers are required to measure lengths accurate to sixteenths. Because this involves fractional quantities, an educator may simply be told, "They can't do fractions". This may well be part of the problem, but an educator talking to supervisors and watching workers doing their jobs will be able to clarify just what aspect of "doing fractions" is relevant (e.g., inability to distinguish 1/8" from 1/16", or adding 5/8 and 3/16), and whether any other factors are involved. In addition, discussions with workers, supervisors and union representatives will allow an educator to discover whether there are other educational needs in that workplace.

**Characteristics of successful programs**

However, the educator must first convince the initial customer, the company's management or a joint union/management committee, that a custom-designed approach is the best way to proceed. Such an approach involves assessing the overall needs of the workforce, both on the job and more generally, and setting up a variety of educational experiences. Some of these will be targeted directly at job-specific skills to address the organization's immediate needs, and others at providing a wider education to meet the longer-term goal of developing a more highly-educated workforce. An educator can use as evidence for this purpose the following characteristics of successful workplace education programs (Mikulecky & Lloyd, 1993, p. 3).

- They are multi-strand: instruction varies by population and is long-term.
- Customized curriculum integrates basic skills instruction with workplace applications and materials, and also materials connected with home hobbies and personal demands.
- There is active involvement of major stakeholders, such as management, employee organizations, instructors, and the learners themselves.

A **multi-strand approach** provides a number of different courses for a workforce, acknowledging that not all workers are at the same numeracy level. Some will be able to go straight into technical training, while others will need to up-grade their basic numeracy skills first. Thus, a range of courses and instruction can cater to different job needs and different levels of need. This approach also acknowledges the pattern, and often the organizational requirement, that each course be of short duration. Employers are reluctant to release workers from their productive role for long

periods, so workplace instruction is often very short: 20 - 30 hours spread over 5 - 8 weeks. A range of different courses provides sequences of such learning experiences, so that workers can develop steadily over the long term and take increasing personal initiative as life-long learners. The advantages of this model to the organization are that workers continue to learn, and thus are more likely to retain what they have already learned, and that they become better educated and more flexible in an environment of changing jobs and expectations. In contrast, a quick fix of "They can't do fractions" will be a single short course with standard content for all, which will probably be quickly forgotten. Multiple strands may cost more in total, but are much more likely to produce lasting results. In other words, they are cost-effective for the organization.

In addition, a multiple strand program allows the flexibility of including instruction which can be seen as a worker benefit: GED or everyday math, for example. And other education offered may be chosen by the employees. Doing this lets employees see that the program is not just a way for management to increase productivity, but also has something for them. It is more likely that workers will be interested in participating in such a program, including the technical, work-based education, if they are directly involved in this way.

However, in some workplaces, it may not be possible to set up a full multi-strand program straight away, so a gradual approach may be required. The merits of various starting points are discussed in a later section on "Alternative models".

### Advantages of Multiple Strands

- Provides a range of instruction for different levels of need
- Provides sequences of instruction to allow continuing education
- Produces flexible workers, oriented to education
- Can provide a mix of job-specific and more general learner-centered instruction

**Custom-designed curriculum** allows educators to link what learners need to know with what they already know, building on the existing skills and knowledge of adults. Thus, instruction can be targeted at very specific goals, such as comparison of fractions to assist with measuring, and can use the learners' everyday experience, both on the job and away from work, to assist with their learning. Example materials from the workplace and from home (some of it brought in by the learners) can be used in class to reinforce the real nature of what they are learning. These materials can be supplemented by carefully selected off-the-shelf materials that reflect workplace tasks. When workers leave the class, they will continue to use the workplace and home materials, thus gaining extra practice time beyond the brief period available in class. Another benefit of focused instruction concerns the limited nature of transfer of learning. Most learners have difficulty transferring the use of a new skill from one context to another without help. However, if what they are learning is directed toward a specific workplace goal, they can be assisted with the transfer from classroom to real-world applications by the instructor, and this link can be reinforced each time they move from job to class and back again. Just like multiple strands, custom-designed curriculum is likely to produce lasting learner gains and so prove cost-effective.

The time factor mentioned earlier as a reason for multiple strands also points toward custom-designed instruction. In the short amount of time available to workplace educators, an instructor's goals need to be limited and clearly focused. Raising the overall general numeracy level of workers who can barely add and subtract is a slow process, taking many hundreds of hours, but more rapid progress may be achieved on a very specific goal directly related to a workplace task. A

comparison of the time allowed for workplace courses with that taken in school is illuminating. Kloosterman (1992) compared the amount of time allocated to basic mathematics skills in two workplace mathematics programs (UAW/Ford learning modules and JSEP computerized lessons) with the time allocated to the corresponding topics in the middle school curriculum. He found that schools spent from five to ten times as long to cover similar material. Thus it can be seen that workplace courses are more concentrated, and therefore need to be very clearly focused. Indeed, most workplace programs are able to afford even less time in classrooms than the 40 - 80 hours of the two programs studied by Kloosterman. In order to overcome this problem of limited time, some employers have experimented with computerized instruction linked to job skills (see Haigler, 1990) and learning modules which can be used at home or during down time at worksites (see Mikulecky & Philippi, 1990).

**Advantages of Custom-Designing**

- Deals with perceived problem
- Job-related curriculum
- Sets specific goals
- Good use of short time available

The third characteristic of successful programs is **active involvement of major stakeholders.** If all parties involved feel that this is their program, then problems are less likely to occur. Any difficulties that do arise can be readily overcome in a cooperative environment, where everyone wants the program to succeed. Therefore, all parties must be convinced that the program offers them something of substance. Initially, management may want improvement only in job-specific skills, so that productivity rises. But the union may want a general education program to enhance the lives and employability of its members, possibly including courses in home repair, consumer decisions and hobbies. These apparent contradictions can be resolved by offering several courses in a multiple strand approach, and by pointing out that the whole package will produce gains for all parties. Management will benefit from general education courses held in an overall workplace context, since their workforce can become better educated and more flexible. Workers will benefit from job-specific education, because they can gain additional skills to help them with promotion or security in their present jobs. When all affected parties are involved in setting up a numeracy program and all feel that they will gain from its implementation, the resulting positive atmosphere is, in itself, an indicator of probable success. The more people who "buy in" to the program the better.

Clearly, the three characteristics just described are intertwined. Setting up multiple strands allows for a variety of courses to meet the needs of different groups. Some of these needs can best be met with custom-designed courses. And positive involvement follows from seeing your needs being met.

### Gaining management support

Now let us look in more detail at the issues that are likely to arise when an educator is seeking initial management support for a program that includes the characteristics above. As mentioned earlier, the educator is probably talking to management because of a particular problem that is costing the organization money in some way, or in anticipation of a problem connected with restructuring—retraining or down-sizing, for example. In order to move beyond this one problem, the educator needs to find out in what other areas the organization has problems which interfere with the achievement of company goals—"Where is the pain?" For a manufacturing company, this pain may include too much scrap from errors in production. For a service industry, it may mean

billing errors leading to customer dissatisfaction. In any area, it could include supervisors' time being wasted in correcting the mistakes of the workers under them. If an organization is introducing Total Quality Management, there will be a need to empower workers to do more without close supervision—which will require higher levels of basic skills. When an educator can identify these problems and obtain some information on what they are costing the organization, then management is more likely to be convinced of the need for custom-designed education, directed at the real problems affecting the organization.

**"Where is the pain?"**

- Wastage of materials — too much scrap?
- Customer dissatisfaction — billing errors?
- Safety issues — too many accidents?
- Customer dissatisfaction — low quality product?
- Wastage of time — mistakes need correction by supervisors?

Managers should also appreciate the efficiencies of time involved in custom-designed courses. They will usually not be prepared to have workers in class and away from their jobs for extended periods of time. So the targeted instruction that arises from custom-designing is likely to prove a selling point, not only for dealing with the "pain", but also for dealing with it quickly. In addition, the short amount of class time spent on job-related materials will be augmented by further practice with those materials when workers are back on the job. So the value obtained from custom-designed instruction will be enhanced by its close ties with job practices.

Once an educator has support among management for custom-designed education to solve several different problems, the idea of multiple strands follows. There may be a need for training in blueprint reading *and* in accurate measurement. Or there may be a need for training in data entry *and* in calculator use. Also, not all employees with a problem will require the same level of training. If, for example, a course in Statistical Process Control is needed, some workers will be able to go straight into the course, while others will need first to up-grade such basic numeracy skills as decimals and averages. Thus, a range of courses and instruction provides the flexibility to cater efficiently to different levels of need.

Providing several strands of education also helps to solve a problem arising from the brevity of much workplace instruction: how long will knowledge be retained? If workers can link one instructional experience to another (for example, following basic decimals and percentages with health benefit deductible and co-pay calculations), then they can reinforce newly-acquired skills by applying them in a subsequent course, as well as on the job.

Thus, a range of courses and instruction provides the flexibility to cater efficiently to different levels of need. It may be, however, that an organization is reluctant to embark on a fully fledged multi-strand program at first. Then decisions must be taken about the best way for the program to begin. To help an educator weigh the possibilities, several different options are laid out in the section below entitled "Alternative models".

Finally, however, we come down to results. For a program to be able to continue beyond its first wave of classes, it must reach its goals. And these goals need to be established at the outset.

An educator should clarify with management what is to be the end-product of each technical training course or instructional module, and how the achievement of goals is to be measured. Given the likely restrictions on time for workplace instruction, it is important to set realistic goals in the time-frame allowed. And, if the program is to be seen to reach those goals, there must also be realistic assessment measures. Education targeted at job-specific goals needs job-specific measures of success. A standardized test may be quick and easy to administer, but in 20 or 30 hours of instruction it is not likely to show much gain. Just as the curriculum of the workplace program has been custom-designed, so must the evaluation be custom-designed. If one program goal has been to increase workers' ability to complete Statistical Process Control charts, then suitable measures include job simulation scenarios of SPC charting and supervisor ratings of the workers' skills with SPC charts.

Only if realistic goals are set and learner assessment is directly related to curriculum, can a custom-designed workplace program show that it is a better option for the organization than a cheaper off-the-shelf package. If it can show this, then success will lead on to more success for that program.

**Gaining worker and union support**

Gaining *management* support is only part of an educator's task in the planning and negotiation phase; equally important is gaining *worker* support. Because an organization's employees will be the "customers" for a workplace numeracy program, it is most important to convince them that the program is worthwhile. Just as management's needs can be approached through the question, "Where is the pain?", so workers' needs can be discovered by asking about their concerns in relation to their current jobs, employment more generally and their wider education. To find out about these issues, an educator should arrange to visit the workplace accompanied by a union representative or an employee opinion leader. After being introduced, the educator can talk to individual workers—in lunch or break rooms, and also on the job if the working environment is suitable (and safe) for visitors. Such visits achieve two purposes: not only can the educator learn about worker concerns in relation to education and training, but also start becoming a familiar figure in the workplace, which will assist with recruiting once the program is under way. (See Henard, Lloyd and Mikulecky (1992) for further details on site visits and recruiting. See also Mikulecky et al (1992).)

A multiple strand program is the ideal vehicle for satisfying the needs of workers, as well as of management. Within this structure, an educator can include courses that can be seen as worker benefits: GED or hobby math, for example, depending on demand. This shows employees that the program is for them, and not just for management. They are more likely to be interested in such a program, even the job-related education, if they are involved in this way. The best way to get people to buy-in to a program is for them to feel that it is their program.

**Consulting Workers**

- Discover their concerns — job retention and advancement, further education
- Lay the groundwork for recruitment to classes
- Encourage worker buy-in to the program

Many industries, particularly in the manufacturing sector, are largely or completely unionized. It is important for an educator coming into such a workplace to find out what the goals of the union

are in relation to education, and how union and management work together in that workplace. Many of the union's goals will overlap with management's: for example, keeping the plant open and operating competitively. But other union goals will relate to more general concerns of the workers, such as increasing their overall skill levels in order to obtain greater job security, or enhancing their quality of life through education. The latter may include, for example, targeted courses on home repair or consumer decision-making. The UAW/Ford National Education, Development and Training Center, for example, requires that all training developed through its efforts have a focus upon personal growth and development of employees. When this center developed a model industrial mathematics program with funding support from the U.S. Department of Labor, resulting materials were designed to have a balance between 50% workplace examples and 50% home use examples (Mikulecky & Philippi, 1990). Without the emphasis on personal growth and development, union involvement would not have been possible.

An educator working in a union setting should find out about union goals by talking with union leaders, and then involve them in program planning. As with management and individual workers, the earlier the union buys into the education program the more they will see it as their program. The desirable qualities of multiple strands and custom-designed curriculum fit in well with this aim. Where union goals diverge from management goals, both parties can be satisfied within a multiple strand framework: for instance, with technical training for management and general education for the union. In addition, if the union has specific educational goals, such as teaching their members about retirement packages, then courses can be custom-designed to do this.

It is also possible to combine some apparently differing goals of union and management, by relating workplace tasks to everyday tasks. For example, accurate measurement can be taught using both workplace and home examples (e.g., woodworking, sewing, home repair). Other examples of links are the parallel teaching of:

- reading inventory graphs and reading newspaper graphs,
- calculating percentages in a bank and calculating percentages for retirement benefits, and
- using tables for insurance premiums and using tables for sports scores.

Assignments can encourage out-of-class practice, and possibly double in-class practice time, by seeking applications at home and work. More general strategies, such as using various forms of mathematics in communication and problem-solving, can be taught using both workplace and everyday contexts, thus at the same time satisfying both union and management and providing workers with opportunities for additional practice of the skills they are learning.

However, a word of warning is due here. Research suggests that most learners do not make the link between the contexts described above entirely by themselves. For most people, the ability to transfer learning from one situation to another is very limited (Mikulecky, Albers & Peers, 1993). So learners will need help. The instruction will have to make explicit links between different uses of graphs or tables, and different problem-solving situations. With such assistance, workers may learn how to make those links in the future, but it would be dangerous—and counter-productive—for an educator to assume that connections obvious to her are also obvious to her students. In order for transfer of learning to take place, it is wise and usually necessary to teach for that transfer.

**Possible Union Goals**

- General education and personal development — quality of life
- Raising skill levels — job security
- Targeted courses on hobbies, home repair, consumer decisions or retirement

A particular concern of unions and individual employees is the use that management might make of learner assessments. This includes both diagnostic tests used to place learners with appropriate teaching materials and pre- and post-tests used to evaluate the success of the program. A clear and unambiguous policy of confidentiality is the best approach here. An educator should obtain the agreement of all parties that *individual* learner test results are available only to the teacher and that learner. In order to evaluate the program, management and unions should have access only to results for *groups or classes*. If this is negotiated early on, an educator is more likely to obtain the confidence of all parties—and to retain it.

Most of the discussion in this section has addressed worker concerns by relating to an organized union. Some educators mistakenly assume that, if there is no union, one need only address management concerns. In actual practice, the educator's task is made more difficult in some ways when there is no labor organization. Worker needs and concerns must still be addressed, but the educator has no pre-existing organization to help gather information, recruit students, and endorse educational activities. In this situation, an educator will need to initiate contact with the workforce through tentative discussions with individuals and groups, to discover who are the employee opinion leaders. Because of the informal nature of this liaison with workers, the educator will find it necessary to check back with a cross-section of worker opinion at each step of program development. In fact, it may be advisable to start the program with a small class of interested workers, and expand once that is successful by word-of-mouth advocacy from those first students. But, however this difficulty is overcome, educators must certainly take account of workers' concerns if they are to involve those workers in a successful program.

In summary, it can be seen that, within a multi-strand workplace program, the interests of workers and management can be mutually supportive, rather than antagonistic. The more education a company's employees receive the more valuable they are likely to be to the company. If one educational experience can lead to another within a structured series of courses—some general basic skills, some job-specific technical education—then each will support the others. Attention to transfer and linking of contexts both in the materials and by the instructors will help increase learner practice and application of new skills.

**Alternative models**

As mentioned earlier, what has been presented above is an ideal which may not be immediately achievable in a particular workplace. Limits on funding, availability of personnel and worker release time may not allow a full multi-strand program to start at once. However, it *is* an ideal worth aiming for, possibly in the longer term. It is also a situation that may just happen as a program becomes established. For example, the technical education course initially set up may be seen to require basic skills instruction as a lead-in for some workers. Then, with interest in education growing, the union may ask for a GED course or a retirement preparation course. And so on, until three years down the road, the program has grown from one technical course to a true multi-strand program.

The question remains, however, of where is the best place to start. This will depend to a large extent on the nature of the particular workplace, but there are some general advantages and disadvantages which can be stated for the various possible models. These are set out in the table below.

## Examples of Possible Models for Workplace Numeracy Programs

**1. Technical education only**

Advantages: focuses on job-related tasks
quick and efficient

Disadvantages: possible gap between worker and material
lack of worker incentive

**2. Technical education integrated with basic skills support**

Advantages: focuses on job-related tasks
bridges gap between worker and material

Disadvantages: potential lack of worker incentive

**3. GED only**

Advantages: raises general education level of workers
provides personal incentive for some workers

Disadvantages: progress very slow with generic materials
lack of transfer to job-related tasks
not appropriate for all who need help

**4. Multi-strand (including technical education and GED)**

Advantages: focuses on job-related tasks and worker home tasks
raises general education level of workers
long-term educational experiences
provides worker incentive

Disadvantages: more expensive than other options

## Designing Curriculum

The amount of custom-designed curriculum required for a workplace numeracy program will depend on the choices made from the options in the table above. If a GED class is the sole offering, then little curriculum will need to be designed. There are many text books available and a

teacher's principal task before class begins will be choosing among them. However, when job-related instruction is to be included in a program, a great deal of planning and preparation is required before a teacher will be ready to enter the classroom.

Before deciding what to teach in such technical education courses, an educator will need to find out what are the areas of difficulty for workers and "pain" to the organization. Interviews and observations of workers carried out at the planning stage will give an indication of what the general problems are, but more detail is required before specific teaching materials can be developed. The first step is to conduct a task analysis, to find out which skills are problems for workers doing the jobs targeted for education. Then curriculum materials can be custom-designed to address those skills seen as highest priority, with off-the-shelf materials being found to supplement these and address other, but less important, issues. Teaching adults who may at first be reluctant to return to the classroom also presents its challenges. As important as covering the curriculum is establishing an atmosphere of confidence and trust, so that workers who left school some years ago—and have no fond memories of that experience—are able to benefit from the job-related education that is now available to them.

**Task analysis**

A task analysis involves interviewing personnel at all levels of the organization about their perception of the problems, gathering numeracy materials used in the workplace, and observing workers carrying out numeracy-related tasks. From these various sources, an educator can analyze the skills and tasks involved with each job under consideration and decide which parts of these tasks are causing problems in the workplace. Then curriculum materials can be custom-designed to address these problems, producing instruction (i.e., courses, modules, exercises, computer-guided instruction) targeted to improve productivity, reduce wastage, or whatever workers and the organization need.

**Carrying out a Task Analysis**

- Interview personnel: workers, supervisors, managers, union reps, trainers
- Gather materials used on the job: forms, graphs, charts, instruction sheets
- Observe workers doing their jobs: make notes, ask questions
- Analyze job tasks into sub-tasks and skills: concentrate on problem areas

An educator's first step in finding out just what is needed is to **interview personnel** relevant to the jobs being analyzed. This will probably include the plant and personnel managers, the workers themselves, their immediate supervisors, union representatives, and the training director (if the organization already has some training in place). Questions to ask will need to be appropriate to the person interviewed: managers will have a broad view of the problem, but workers and their direct supervisors will be able to give you more detailed information.

For instance, a plant manager should know which jobs are most affected by a lack of numeracy skills, including major productivity and accident problems. For a particular job, a direct supervisor should know about the consequences of poor performance in these areas, and about loss of time due to workers covering for others who lack necessary skills. And, taking another slant, a personnel manager should know about numeracy as it affects hiring and promotion, and workers'

understanding of pay checks, benefits and claim forms. (See Drew and Mikulecky (1988), Figs 2 and 5, for further details.)

To support the information from these interviews, an educator should **gather materials** that show how numeracy is used in the workplace. This could include forms, graphs and charts, computer print-outs, blueprints, instruction sheets, and copies (drawings or photographs) of important machine displays. Where relevant, obtain examples of these materials completed by workers—forms filled out or graphs plotted, for instance. This will show how well workers can use these materials, and where they make errors. The interviews themselves will probably be a good source of these materials, because interviewees are likely to produce examples to illustrate the problems that they see.

Finally, and most important, an educator should **observe workers** doing the job tasks that are causing difficulties, in order to find out just what is the problem. Direct observation of experienced workers is the only way to find out the actual methods used on the job, which may not be those set down in the procedure manual. Often observations will lead to new questions and important information needed to custom-design curriculum. A side benefit for the teacher who does such task analyses is that later in class she will have the added credibility of job knowledge. One goal of the task analysis is to analyze the task into meaningful sub-processes and skills in order to determine problem areas connected with that job. Criteria for deciding which skills and processes will need highest priority during class time include:

- Do new workers typically stumble or take a long time to master certain steps?
- Do many workers have difficulty?
- Is a lot of supervisor time taken up correcting errors?
- Are errors expensive—in materials, time or lost customers?
- Can errors cause safety problems?

During the observation of workers, an educator should take detailed notes on what she sees, and ask workers to explain what they are doing—and how they are doing it, to reveal thought processes not visible to the observer. If this cannot be done on the job, follow-up interviews can clarify ambiguous areas. This will enable a **full analysis** to be made of all the skills needed for that job, so that the curriculum devised to teach workers in that job will be able to concentrate on the real areas of difficulty, without omitting any important links. (See the example of Task Analysis in Figure 1 at the end of this section. See also the list of further resources at the end of this section.)

**Custom-designed curriculum**

Once a task analysis has revealed the highest priority areas for training, an educator's next job is to design curriculum which will teach to the skills that are needed. This curriculum should also teach *from* the skills which the workers already have. Those in the classes will have had a variety of experiences, both at work and in their everyday lives, which are likely to be relevant to the skills they now need to develop. (This is true to a much lesser extent for children in school.) An educator should capitalize on this, and teach these adults *as adults*, who have much to bring to the classroom and its practices.

For example, adults who have functioned at work and in society for a number of years will have developed various coping strategies for numeracy situations, which may bear little resemblance to the standard methods of arithmetic taught in schools. Nonetheless, if their strategies work and the learners are comfortable using them, then they should be encouraged to go on doing so. It will boost their confidence to have "their" methods appreciated, and they are more likely to

produce accurate results with familiar processes than with any imposed from outside. So it is important to listen to how workers themselves deal with problems and then build on their current skills, extending the range of what they are able to do—and are confident in doing.

An instance of problem-solving through experience is provided by Scribner (1984). (See also Harris (Ed) (1991), pp. 204 - 206; Berryman & Bailey (1992), p. 47.) In the dairy industry, product assembly workers make up the loads for delivery, using an order sheet where quantities are expressed in whole cases plus or minus a number of quarts. To make up a particular order, the workers may either add quarts to a case or remove them to reach the correct order. The most obvious solution to the problem is to carry out the description on the order sheet: for example, 2 cases minus 6 quarts involves picking up 3 cases and removing 6 quarts from one of them. However, a worker may have available some previously opened cases, and it may be that the order can also be satisfied by adding quarts to one of these cases. The number of quarts in a case varies from product to product, but let us suppose that a case in our example contains 16 quarts. Then a worker with a previously opened case containing 8 quarts has only to add 2 quarts to this case to satisfy the order's requirement for a partial case with 6 quarts missing. Therefore, in this example, the worker can save some physical effort (moving 2 quarts instead of 6) by using features of the situation which are not immediately obvious. Scribner's study shows that these unskilled, low-level workers used a labor-saving mixture of obvious and non-obvious strategies: in the majority of situations where the obvious solution was used, it was the most efficient—and, in *all* situations where a non-obvious solution was used, the workers had found the most efficient way of making up the order.

Another area in which adults working in context are very different from school students is their ability to detect that an answer is unreasonable. Many students will simply not check that their results make sense, even when continually reminded. (Trees are 5,000 feet high, the moon weighs 3 lb—and no questions are asked.) This is principally because much of what these students are doing has no real meaning for them. The situation in schools is slowly changing through such efforts at real tasks as the SCANS activities (U.S. Department of Labor, 1991), but there is no need for an adult educator in a workplace ever to fall into this trap. Ready-made contexts surround the workers in an education course, and it is up to the teacher to relate the learning of skills to a mix of job-specific and everyday examples.

### Developing Curriculum

- Custom-design the most important topics using job materials: develop exercises and simulations to practice job skills
- Choose suitable supplementary materials to support custom-designed curriculum
- Work with the experience adults bring to the classroom: build on existing knowledge and skills

However, custom-designing curriculum takes a great deal of time and it is unusual for an educator to be given the resources to customize a complete course. More often, curriculum will need to use a mixture of custom-designed and off-the-shelf materials.

The task analysis for the jobs under consideration will reveal the most critical areas for instruction to concentrate on, and here is the place to build in the custom-designing. Using on-the-job materials gathered during interviews and observations, an educator can construct exercises and simulations which practice the needed skills in a realistic workplace context. In addition, a teacher

can provide further practice of these skills using related everyday materials, possibly brought in by members of the class. (See Figure 2 at the end of this section for an example of curriculum linked to the task analysis in Figure 1.)

As a supplement to the custom-designed part of the curriculum, an educator will need to select from published materials—such as textbooks, videos and computer packages—items suitable for the course being taught. Points to bear in mind when selecting these materials include:

- Are its content and style appropriate for adults?
- Is it for group work or individual self-study?
- Do its methods and content meet course goals?
- Is it written at a suitable reading level?
- Is its price appropriate to its usefulness?

For example, in a Statistical Process Control course, one topic will be basic statistical techniques involved in the calculation of means and ranges. The primary teaching materials should be the actual forms used by workers on the job, but some supplementary practice will probably be needed. For this, a textbook that includes examples of the calculation of means will provide extra practice without a large investment of preparation time on the part of the teacher. The teacher's effort here will be in the selection of the material, making sure that it fits in with the spirit of the rest of the course, supporting it rather than contradicting any aspect of it.

Thus an educator's goal in a technical education course is to provide a series of learning experiences, using custom-designed and supplementary off-the-shelf materials, which link workers' present skills to the skills they will need in their jobs now and in the future.

**Teaching strategies**

The percentages of workers at Levels 1 and 2 of the National Adult Literacy Survey indicate that workplace education is addressing a very serious problem. In order for an educator to raise the *general* proficiency level of such workers would require hundreds of hours of instruction, an amount of time not usually available for workplace courses. However, by concentrating on *specific* workplace tasks and skills through custom-designed curriculum, it is possible to make a difference—in those areas—after a much shorter time. In addition, by teaching job-related skills, an educator has an opportunity to build on the workers' experiences during the rest of the week when they are not in class. On the job, they are performing over and over again the tasks that form their curriculum, so that they are continually practicing the skills being taught.

To capitalize on this repetition and immediacy of workplace tasks, an educator needs to teach with materials from the workplace. The choice should come from materials which those in the class are using every day in their jobs—and which are causing problems. This comes back to the question of "Where is the pain?" If workers are having difficulty filling out order forms, calculating delivery charges and totaling bills, then their instruction should concentrate on these skills and teach with the actual forms they use on the job. In addition, to encourage flexibility, they can also work with similar forms from other contexts which require filling out and calculating. These can usefully include forms that the workers meet in their everyday lives outside work. In addition, for workplaces where increased flexibility is desirable or for workers seeking transfers or promotions, forms from other workplace contexts can widen the range of applications that workers feel comfortable with—"Where is the *gain*?", as well as "Where is the pain?" However, an educator must be careful to make the link between the various contexts explicit. As remarked earlier, many people cannot easily transfer their learning from one context to another without such help.

### Teaching in Context

- Use workplace materials — relate directly to job
- Use similar everyday materials — make link explicit
- Teach skills as part of realistic tasks rather than isolated activities

So, in order to be successful, job-related numeracy instruction should teach skills that are needed on the job now. Teaching should be based around job materials with which workers are having difficulty, and which are causing the organization "pain" in some way: loss of production, or quality, or customers. As much as possible, skills should be taught in the setting of realistic tasks and solving real problems. This will allow the workers to learn more readily, with continual reinforcement when they return to the job. Also, because instruction is concentrating on an area of "pain", it will be able to make a difference to the organization's bottom line.

So far, we have looked at *what* to teach; now let us turn to *how* to teach in a workplace setting and consider the kind of people this instruction is aiming to help. The experience of many workers with numeracy in schools was often a negative experience with failure or with meaningless abstractions. At school, some were among those who "never could do math" and had a fear of "word problems". Others were able to carry out routine calculations using a method they had just been shown or to do problems "set up" by somebody else. These adults often had little or no understanding of what lay behind the method they had used and soon forgot. Very few adults leave school with a "problem-solving" attitude about mathematics, but many are now expected to deal flexibly with day-to-day mathematical problems, choosing appropriate techniques and applying them to real-life situations. In many workplaces, therefore, it is not just a case of teaching specific mathematical curriculum. There is a deeper problem of confidence, motivation, and productive ways of seeing mathematics, which an educator needs to address.

### Teaching to the Learner

- Provide support and encouragement — boost learner confidence
- Prepare the ground for new concepts — link them explicitly to previous knowledge
- Teach from what the learner knows — build on firm foundations

In addition to the general support and encouragement that an educator needs to give in such situations, it is particularly important when teaching numeracy skills to make sure that the learner has sufficient background to understand the concepts being presented. In mathematics, most concepts are built on other—more basic—concepts, and these must be understood before a new concept can be built on them. Having covered the material previously is not sufficient. The foundation knowledge must still be in the learner's head to be of use. The failure of teachers to appreciate this fact is probably the most common cause of students being unable to do math successfully and with confidence.

Therefore, the adult educator needs to keep very much in mind the dangers of arranging for yet another failure when dealing with workers whose numeracy skills are low, but who are being expected to operate at a sophisticated level of problem-solving. The temptation is to say that you can teach Statistical Process Control to low-level numerates in 30 hours, but the result on the shop floor is likely to be confusion: half-understood ideas being misapplied, producing high levels of waste and machine down-time. It is much better to allow the lower-level numerates to build up their skills and confidence in a pre-SPC course, preparing the ground for the statistical calculations they will need to do. If a teacher finds out each worker's current state of knowledge, it is then possible to build up from a firm basis toward the required skills.

## Evaluation

Program evaluation is sometimes viewed as an optional extra, without the same importance as curriculum development or teaching strategies. But, in a workplace context, it is vital for the continued existence of the program. Future funding, either from the company or from a government grant, is usually contingent on the program showing that it is succeeding. This means demonstrating that workers have improved in the skills and competencies being taught. Therefore, an educator needs to think just as carefully about evaluation as about curriculum—and just as soon. If the evaluation is to show *gains* in workers' job-related basic skills, then it is necessary to know where they started. Base-line data on worker abilities should be gathered at the beginning of instruction, so that this comparison can be made. Also, in order to show gains in *workplace* skills, the instruments used to assess learners need to relate to those skills. An evaluation is more likely to show that a program is effective if learner assessment is closely linked to both teaching and job skills.

Too often a workplace education course, if it is evaluated at all beyond informal surveys of employee opinion, will rely on learner assessment that uses a standardized test as the only effectiveness measure. There are two problems with this. In the brief instructional time available for most workplace instruction, learners will make very small gains in the broad, general abilities which published tests assess. On the other hand, the improvements in workplace competency that the learners have probably made may not be directly measured at all. Such results can make it appear that instruction is not succeeding, and the organization funding instruction is unlikely to continue doing so.

Therefore, when evaluating the effectiveness of teaching on-the-job skills with custom-designed curriculum, an educator will need to develop some custom-designed assessment measures as well. (If you want to see if workers have learned from your class, test what you teach.) The same source that provides teaching materials—the workplace itself—should also provide the materials for evaluation. Using these, an educator can develop workplace competency tests and job simulation scenarios which highlight the particular basic skills covered during instruction. Complemented by employee ratings by supervisors, these will give a good idea of the effectiveness of instruction in improving, for example, productivity, safety, or customer satisfaction. Once again, in order to show learner *gains*, it is necessary to administer these measures as both pre-tests and post-tests—before instruction begins and then at the end of a course.

There is a slight problem involved in using exactly the same measures for both pre-test and post-test: learners' detailed memory of what they have met before. But it is generally accepted that this detailed memory will decay sufficiently provided that at least six weeks elapse between tests and if feedback is not provided on answers to questions. Most workplace basic skills instruction lasts for six weeks or longer. The alternative to using the same test is to have two validated and parallel forms of measures available, but it is a very expensive procedure to field-test two custom-

designed forms to show that they are equivalent. Most workplace programs do not have the resources to do this. In fact, during a given year total learner numbers are usually smaller than would be required for a valid trial of two parallel tests. So the most reasonable way to ensure a fair assessment of learner gains is to use the same test before and after instruction.

This assessment should include a variety of ways of evaluating the gains workers have made in improving their workplace numeracy performance, from direct measures of their own skills to ratings of their work by supervisors.

**Custom-Designed Evaluation**

- Workplace skill and competency tests
- Scenarios simulating job tasks
- Job performance rating scales

Compare **pre-test** and **post-test** to measure learner gains

and program effectiveness

One direct method is a **test of workplace skills and competencies**. This can include short exercises on the areas important to the workplace that were covered in instruction. For example, in a health benefits office, questions could include extracting information from a table and calculating payments due in certain situations. (See example in Figure 3 at the end of this section.) A disadvantage of using a test like this is its tendency to fragment workplace tasks into small and artificial pieces. But this can be overcome by using a more extended, multiple-step simulated job scenario.

A **job scenario** uses an actual workplace document and leads the worker through a realistic simulation of a job task that has been taught in class. This is often conducted in interview form to avoid reading problems which are not part of the task. The scenario could involve completing an SPC chart and deciding on a course of action, or filling out an order form and totaling the bill, or reading a graph of production problems and discussing likely solutions. (See example in Figure 4 at the end of this section.)

Both of the evaluation measures mentioned so far have the advantage of assessing the workers' competencies directly, but have the disadvantage of taking place away from their actual job where environmental cues may help performance. So it is highly desirable to supplement scenarios with some measure of the workers' actual job performance at skills covered during instruction. Ideally, this would be a measure of productivity, but very few organizations gather productivity data on individual employees. So, usually, a more feasible means of finding out how job performance has been changed by instruction is to use employee rating scales, filled out by the workers' supervisors or other personnel with a detailed knowledge of their work. In some workplace situations, particularly where work teams are operating independently, it is more appropriate for the team to make these ratings or for the worker to use them as part of a self-evaluation.

These **employee ratings** should have separate scales for each of the aspects of numeracy which are important for doing the job and which have been addressed in instruction. These might include

- setting up and operating machines,
- keeping up-to-date with forms and paperwork,
- taking the initiative in solving problems,
- interpreting and making judgements with graphic information,
- making accurate measurements and drawing accurate conclusions from them.

So that different supervisors (and the same supervisors between pre- and post-test) use the same standards, the scales should have anchoring descriptors for good, average and poor performance. (See example in Figure 5 at the end of this section.) It is also a good idea for an educator to work through the rating scales with supervisors, who may not be used to making judgments of this kind, so that they assess carefully and consistently. This usually means the educator sitting down with the supervisor, asking the supervisor to think over an employee's performance during the previous week, and then carefully considering anchor points before making ratings on that employee. If rating scales are simply dropped off on a supervisor's desk to be picked up later, there is some danger that time pressures may lead the supervisor simply to circle numbers without giving sufficient thought about recent performance.

In addition to the three types of evaluation measures described above, other workplace factors less directly related to curriculum may be affected by attendance at an education class. Some programs have found that access to classes cuts absenteeism and increases punctuality. Others report impact upon retention and promotion, lowered accident rates, and increased use of suggestion boxes. Many organizations already gather data on these factors, so an educator will need only to collect the figures for workers in the education classes. For further details on all of these evaluation measures, see Mikulecky and Lloyd (1993).

Assessing worker gains is, however, only part of the evaluation process. If an educator is to convince funders that the program should continue, then the results of this assessment must be presented in a form that will point up clearly the areas of gain, relate them explicitly to workplace practices, and link them back to the original question "Where is the pain?". When the program was first negotiated, the organization being served believed that certain goals would be met. In an evaluation report, the educator needs to anchor the assessment results very clearly in these original goals and describe just how they have been met. A workplace program is very much on trial in its first year or two, and the onus is on the educator to prove that the program is succeeding. If this can be done convincingly, and the organization is assured that it is getting value for money, then the workplace numeracy program will be able to continue with confidence—and possibly expand—in future years.

## Implications and Conclusion

There is a clear need for high-quality numeracy education in many workplaces and for many workers. This should include instruction targeted at very specific workplace goals, taught with job-specific materials as part of a custom-designed curriculum. A task analysis should be used to decide the most urgent problems in a workplace, and curriculum then be designed to address those problems efficiently in the short time usually available for workplace education. In classes, educators should draw on the skills that adults already possess, linking them to the skills needed in the workplace and to related everyday skills.

In order to gain wide support and the active involvement of major stakeholders, an educator should consult management and unions, workers and supervisors, about their training and educational needs. Meeting those needs is most appropriately done within a multi-strand program

offering a variety of educational experiences, which satisfy the needs of all concerned. In this manner, numeracy gains in workplace competencies and general education will reinforce each other, for the mutual benefit of all.

It is unlikely that the limited time available to most workplace instruction will demonstrate large gains on broad-based standardized measures. For this reason, evaluation of workplace instruction should include some custom-designed measures which are directly related to the topics, tasks and materials used during instruction and in the workplace.

**Numeracy Program Checklist**

| | |
|---|---|
| 1. Planning and Negotiation | Consult all groups affected by the program, so as to create active involvement: management and workers, unions and supervisors |
| 2. Identifying Needs | Gather examples of workplace materials and practices, discovering skills problems: interview, observe, question |
| 3. Designing Curriculum | Custom-design curriculum to address worker needs, using workplace materials: forms, charts, blueprints, instructions |
| 4. Evaluating Results | Assess what is taught with job-related measures, and report to funders how goals have been met |

## Further Resources


Carnevale, A. P., Gainer, L. J. & Meltzer, A. S. (1988). *Workplace basics: The skills employers want.* Alexandria, VA: American Society for Training and Development.

This 35 page booklet describes the nature of workplace basic skill demands and outlines the process of establishing a custom-designed program. It is available from American Society for Training and Development, 1630 Duke Street, Box 1443, Alexandria, VA 22313.

Drew, R. A. & Mikulecky, L. (1988). *How to gather and develop job specific literacy materials for basic skills instruction.* Bloomington, IN: Office of Education and Training Resources, School of Education, Indiana University. (ERIC Document Reproduction Service No. ED 297 160.)

This 70 page guide describes in detail how to conduct a task analysis, and includes examples of task interview forms and how to use workplace print materials in teaching. It is available from Vocational Education Services, 840 State Road 46 Bypass, Indiana University, Bloomington, IN 47405.

Henard, D., Lloyd, P. & Mikulecky, L. (1992). *A guidebook for developing workplace literacy programs.* Indianapolis, IN: Office of Workforce Development. (ERIC Document Reproduction Service No. ED 348 580.)

This 120 page guide leads the reader through the full process of establishing a workplace program, from setting up a planning group to evaluating the results. It includes illustrative

examples and anecdotes from the State of Indiana model workplace program, and is available free from the Office of Workforce Development, Indiana Government Center, Indianapolis, IN 46204-2277.

Mikulecky, L. & Lloyd, P. (1993). *Evaluating the impact of workplace literacy programs.* Philadelphia, PA: National Center on Adult Literacy. (ERIC Document Reproduction Service No. ED 348 579.)

This 170 page book describes a new model for evaluating workplace programs and includes detailed examples of assessment measures, as well as the background to the development and implementation of the model. It is available, in either hard copy or electronically, from National Center on Adult Literacy, University of Pennsylvania, 3910 Chestnut Street, Philadelphia, PA 19104-3111.

Mikulecky, L., Lloyd, P., Kirkley, J. & Oelker, J. (1996). *Developing and Evaluating Workplace Literacy Programs: A Handbook for Practitioners and Trainers.* Philadelphia, PA: National Center on Adult Literacy.

This 70 page guide describes the full process of establishing a workplace program, and includes illustrative examples drawn from a wide range of programs. An appendix contains a set of summary overheads that allow the guide to be presented as a series of workshops. It is available, in either hard copy or electronically, from National Center on Adult Literacy, University of Pennsylvania, 3910 Chestnut Street, Philadelphia, PA 19104-3111.

Mikulecky, L. et al (1992). *Developing workplace literacy programs.* (A set of five brochures.) Philadelphia, PA: National Center on Adult Literacy. (ERIC Document Reproduction Service No. ED 348 578.)

This series of five brochures outlines the key issues involved in setting up a workplace program: Gaining Management Support, Working with Management and Unions, Discussing Training Needs, Recruiting Students, and Planning Ahead. These are available from National Center on Adult Literacy, University of Pennsylvania, 3910 Chestnut Street, Philadelphia, PA 19104-3111.

Philippi, J. W. (1991). *Literacy at work: The workbook for program directors.* New York: Simon & Schuster.

This 300 page guide describes in detail how to set up a workplace program including task analysis and custom-designing. It is available, for $200, from Simon & Schuster (1-800-223-2336).

Taylor, M. & Lewe, G. (1990). *Literacy task analysis: A how to manual for workplace trainers.* Ottawa, Ontario: Algonquin College, Adult Basic Education Department. (ERIC Document Reproduction Service No. ED 337 580.)

This 170 page manual describes in great detail how to carry out a task analysis, with samples of forms to use, plus advice on developing training from the analysis. It is available from Glenda Lewe, Suite 2301, 530 Laurier Avenue West, Ottawa, Ontario, K1R 7T1.

Taylor, M. C., Lewe, G. R. & Draper, J. A. (Eds) (1991). *Basic skills for the workplace.* Toronto, Ontario: Culture Concepts, Inc.

This 500 page book contains chapters on the demand for workplace programs, on how to assess worker needs, conduct a task analysis and design curriculum, on example case studies, and on teaching methods and evaluation. It is available from Culture Concepts, Inc, 5 Darlingbrook Crescent, Toronto, Ontario, M9A 3H4.

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U.S. Department of Labor (1991). *What work requires of schools—A SCANS report for America 2000*. Washington, DC: U.S. Department of Labor.

Figure 1

## Task: Counting cash

- recognizing task (identifying key terms and problems)
- organizing bills or coins by denomination
- counting number of bills or coins in each stack twice
- taking notes of the number in each stack of bills or coins
- calculating amount in each stack
- calculating total amount of all bill and coin stacks

| Scenario | Subtasks |
|---|---|
| 1. It's the first thing in the morning. You have to count the cash in your cash drawer before the customers come in. | 1.1 Recognize work-related vocabulary (counting, cash drawer)<br>1.2 Formulate questions:<br>• What is the nature of the task?<br>• What materials do I need to have to complete the task? (cash, pen, cash form, calculator) |
| 2. You start with the largest denomination of bill first. You see that the largest is $50, take that stack from your cash drawer and count it. | 2.1 Remove $50 bills from the cash drawer<br>2.2 Make sure that all bills in the stack are facing the same direction<br>2.3 Count bills by ones, placing each on the table top in front of you |
| 3. To double check your counting, you count the stack again. | 3.1 Count bills again<br>3.2 Formulate question:<br>• Did the answers from both counts match?<br>• If yes, go on<br>• If no, repeat count until answers match<br>3.3 Put money stack back in the cash drawer |
| 4. Write the result of your count on scrap paper. Multiply the result by the denomination to get the amount in that stack. Write the amount on the cash form.<br>*Note:* Repeat steps 2-4 for all bills and coins in cash drawer. | 4.1 Write the answer on scrap paper<br>4.2 Multiply the answer by 50<br>4.3 Scan cash form for $50 line and amount<br>4.4 Write amount in amount column on the cash form |
| 5. Add all amounts to get the total amount of cash in cash drawer. Write the amount on the cash form. | 5.1.1 Scan cash form for first amount<br>5.1.2 Key in first amount in amount column on calculator<br>5.1.3 Press "+" on calculator<br>5.1.4 Repeat steps 5.1.1-5.1.3 for all amounts on cash form<br>5.1.5 Press "="<br>5.2 Read answer from calculator screen<br>5.3 Scan cash form for "total"<br>5.4 Write answer on line to the right of "total" |

Figure 2



# Counting Cash at the Bank

Counting cash accurately is an important bank task. Tellers must keep track of money in their cash drawers. In this activity, you learn how bankers count quickly and make fewer mistakes. You will learn how to:

- **organize and count bills and coins**
- **multiply stacks of cash**
- **add amounts to compute a total**

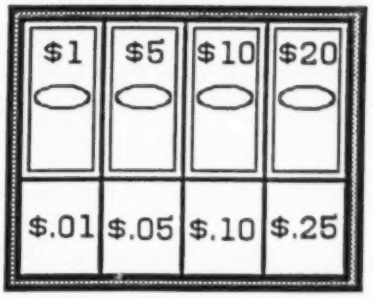
## Looking at a Teller Drawer

James has just been hired by a bank. He must complete on-the-job training with experienced tellers. He must learn how bank employees count cash.

Mark is an experienced teller. He showed James how to count cash correctly. Mark explained how the drawer is set up.

The cash drawer has a bin for each kind of coin and paper bill. Cash in separate stacks and bins is easier to count. Larger bills go under the money tray.

Top Drawer of Mark's Teller Drawer




## Counting Cash

Mark took a stack of $20 bills from the drawer. He showed James how to put each bill into the drawer exactly the same way. The face side is up and goes the same direction as the one below it.

*Right Direction* *Wrong Direction*

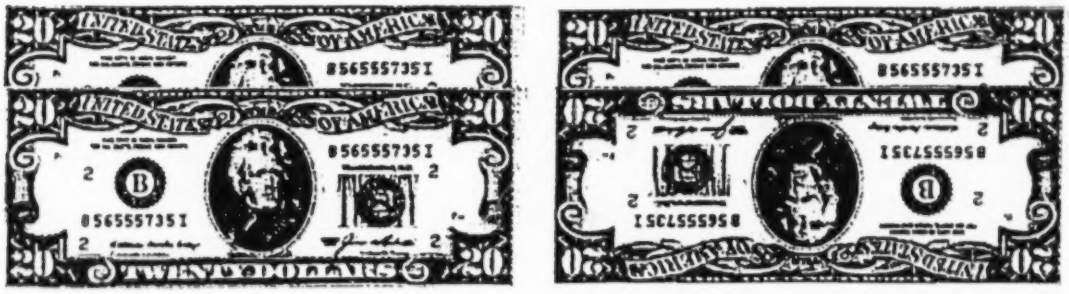


Figure 2 (cont.)



Next, Mark got a paper called a cash form. This paper was used to record cash amounts. Mark explained to James how to count cash.

1. Take one stack at a time from the drawer.
2. Count bills and coins one at a time. Place them on the counter.
3. Count each stack at least twice.
4. Write the kind of cash and the amount on the cash form.
5. Put the stack back in its bin. Get the next lowest kind.

Mark said James should start with the highest kind of bill. Then he should take smaller bills. Lastly, he should count the lowest kind of coin.

Mark also told James some special terms bankers use. At the beginning of the day, each teller starts with cash in the drawer. This is called **beginning cash**. It must be counted at the beginning of each day.

During the day, the teller gets cash from customers as deposits. Other customers receive money as withdrawals. The amount of money a teller has during the day is called **working cash**. This sometimes has to be counted too. The teller always uses the same steps to count each kind or **denomination** of bill or coin.

**beginning cash**
- **bills and coins in the teller drawer at the beginning of the day**

**working cash**
- **bills and coins in the teller drawer**

**denomination**
- **value of coin or bill**

## Writing and Multiplying on the Cash Form

James watched Mark count cash and write numbers on the cash form. Mark started with a stack of $100 bills from under the tray. He held the stack in his hand. Then, he placed the bills on the counter one at a time. Mark counted out loud. He said each number until he had counted all eight bills. He then picked up the stack and did the same thing again. He made sure he had the correct amount.

Figure 2 (cont.)



On the cash form Mark wrote that he had eight $100 bills. He multiplied $100 x 8 = $800. Mark wrote these numbers on the cash form. Mark did this with three more stacks of money.

CASH FORM

| Cash Group or Denomination | Number | Amount |
|---|---|---|
| $100 | x 8 | $800.00 |
| $50 | x 8 | $400.00 |
| $20 | x 20 | $400.00 |
| $10 | x 24 | $240.00 |

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$100 x 8 = $800.00

$50 x 8 = $400.00

$20 x 20 = $400.00

$10 x 24 = $240.00

## Adding Cash Amounts

Mark computed separate amounts for each denomination of bill or coin. He said that multiplying is faster. It helps cut down on counting mistakes. Some tellers lose track or makes a mistake. With this method, tellers need recount only one stack of bills or coins.

The teller adds the cash amounts after counting and multiplying. For example, a teller might have $1000 in $100 bills and $500 in $50 bills and $500 in $20 bills. He or she would have:

$$\begin{array}{r} \$1000 \\ \$\ 500 \\ +\ \$\ 500 \\ \hline \$2000 \end{array}$$

Figure 3

## Calculating Claims and Payments

Calculate the answers to the following problems. Be sure to show all your working.

1. A subscriber submits three claims of $256.00, $1,879.00 and $85.00. What is the total of these claims?

2. A hospital bill consists of 9 units of laboratory at $6.25 and 5 units of anesthesia at $7.29. What is the total bill?

3. Central Hospital increases its room charges by 4.5%. What is the new charge for a room that used to cost $315 per day?

4. Anesthesia units are calculated based on intervals of 15 minutes. For a patient requiring 3 1/2 hours of anesthesia, how many units are needed?

5. Joan J. Doe has medical expenses totaling $2,800. Her deductible is $500 and her insurance program will pay 70%. What amount will the insurance pay?

Figure 4

Process: Graph Example

**Production Problems**

1. I am going to show you a graph. Explain to me how you would read this graph in order to find out what it's about. (*Show attached graph.*" **Production Problems**"). Describe what you would look at. What would you be thinking about? How would you go about reading this graph? What would you do first, then next, then next?

2. (easy factual question)
**What is the total number of culls?**
(Answer: 149. *Shown at top of graph.*)

3. (harder factual question)
**What time period is covered in this chart?**
(Answer: one week or week one in May. *Shown at top of graph in abbreviated form.*)

4. (easy inference)
**What is the biggest problem here?**
(Answer: tear outs. *Longest bar on graph.*)

Figure 4 (cont.)

Process: Graph Example (cont.)

5. (harder inference)
**Find 3 types of problem involving measurement.**
(Possible answers: thickness, length, width, squareness. *Requires selection from list at left of graph.*)

6. (easy application question)
**Pick one problem and suggest at least one cause for that problem.**
(Possible answers: For example, tear outs are caused when the wood gets caught in the machine and is gouged; moulder burn is caused by wood getting caught in the machine and being burned. *Uses interviewee's job-related knowledge.* )

7. (more difficult application question)
**Pick a second problem and suggest both a cause and a solution for the problem.**
(Possible answers: tear outs, caused when the wood gets caught in the machine and is gouged, can be repaired with wood filler and sanding; or moulder knife marks can be caused by gouging of the wood in carving it and can be repaired if you can get at the gouge and sand it and provided the finish hasn't already been applied. *Uses interviewee's job-related knowledge in more depth.*)

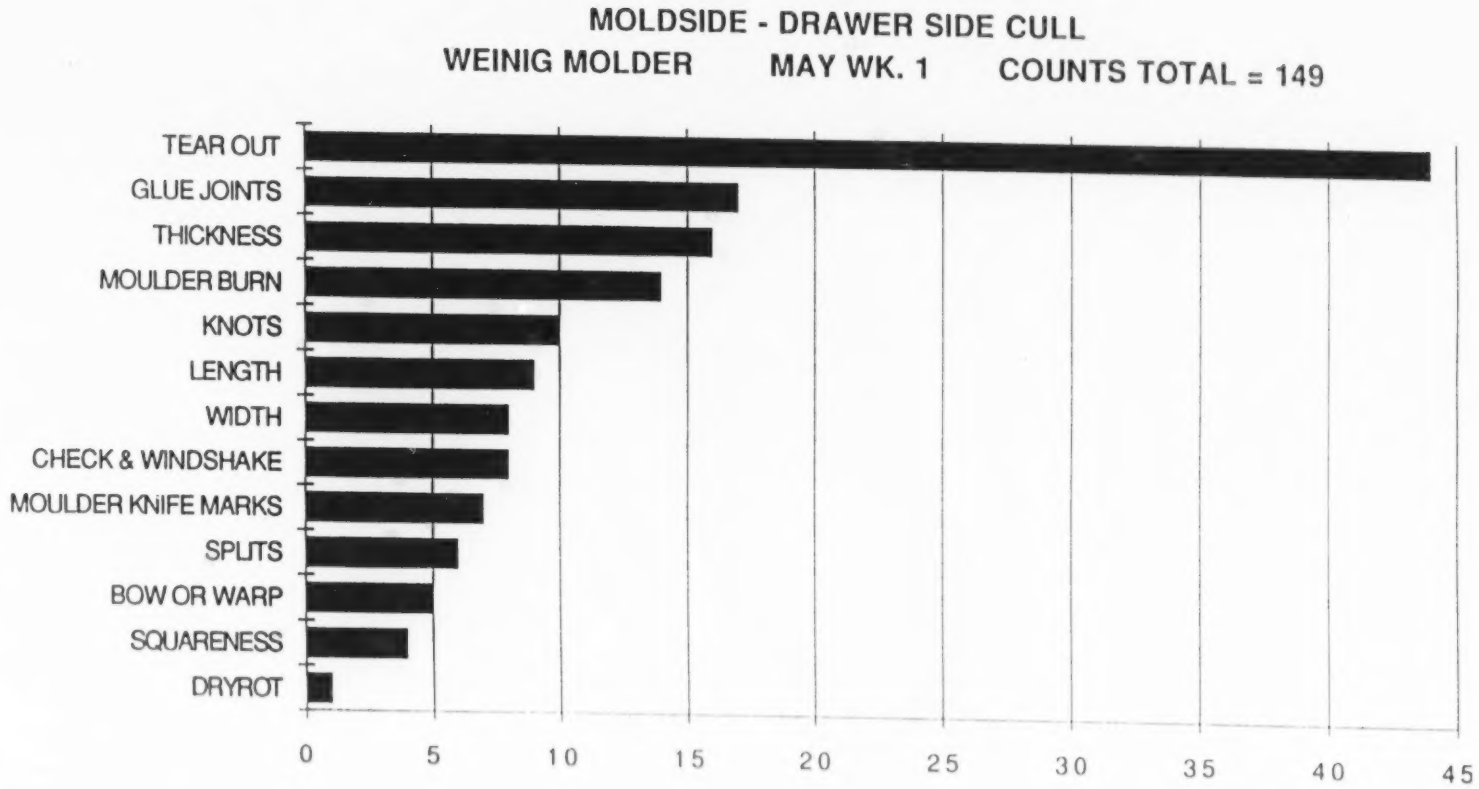


Figure 4 (cont.)

Figure 5

# Employee Assessment - Overall Rating

Please rate each employee on a scale of 1 - 10 for each aspect below.

- An average employee would be rated 5.
- A top employee would be rated 8 or higher.
- A bottom employee would be rated 2 or lower.

**EMPLOYEE** _____ **DATE** _____

**RATER** _____

**QUALITY OF PAPERWORK**

| **Bottom** | **Average** | **Top** |
|---|---|---|
| paperwork provides no or limited information; illegible, poor grammar | paperwork usually acceptable; at times too brief or vague | paperwork is legible, detailed, clear and concise |

**1 2 3 4 5 6 7 8 9 10**

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**MACHINE SETTING**

| **Bottom** | **Average** | **Top** |
|---|---|---|
| unable to set machines correctly | usually sets machines correctly, but doesn't always check settings | sets machines correctly and checks settings thoroughly |

**1 2 3 4 5 6 7 8 9 10**

---

**PROBLEM-SOLVING**

| **Bottom** | **Average** | **Top** |
|---|---|---|
| calls supervisor on minor details or continues to work when equipment is faulty | makes minor adjustments, offers solutions to problems and calls supervisor only when necessary | can analyze job situations, make suggestions and solutions which implement change |

**1 2 3 4 5 6 7 8 9 10**